A Taxonomy of the 'Dark Side' of Financial Innovation: The Cases of High Frequency Trading and Exchange Traded Funds

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Abstract: This paper develops a taxonomy of the 'dark side' of financial innovation and applies it to two recent high-profile financial innovations; exchange traded funds (ETFs) and high frequency trading (HFT). The first half of the paper develops the taxonomy through a review of related literature. Accordingly, the negative effects of financial innovation are categorised as (1) *predatory schemes* (2) *abuse of financial innovation* and (3) *unintended consequences of financial innovation*. The second half of the paper applies the taxonomy to ETFs and HFT, thus allowing for a better understanding of the risks posed by ETFs and HFT. We explore these risks with examples and in the context of current efforts to reform financial regulation following the 2007-2008 'credit crunch'. In the latter case we draw on a G20 survey that explored the capabilities of regulators to mitigate the negative effects of financial innovation. Overall, we conclude that even though both innovations offer potential societal benefits of greater market efficiency (HFT) and more effective diversification (ETF), both pose considerable and contrasting risks. These risks can be mitigated by strengthening regulatory capabilities with respect to financial innovation and by firm level corporate governance improvements.

Keywords: Financial Innovation, Financial Regulation, Financial Risk, High Frequency Trading, Exchange Traded Funds, Systemic risk, EU Policy, Flash Crash.

1 Introduction

The 2007-2008 credit crunch and the subsequent financial, economic and sovereign debt crises have put financial innovation high on policymakers and regulators agendas (Allen & Yago, 2010). This is not surprising since, as observed by Brunnermeier (2009, p.78), the financial innovations *"that had supposedly made the banking system more stable by transferring risk to those most able to bear it led to an unprecedented credit expansion*

that helped feed the boom in housing prices". These complex innovations included collateralized debt obligations (CDOs), structured investment vehicles (SIVs) and credit default swaps (CDS). They have contributed to, or at a minimum exacerbated, the most severe financial and economic crisis since the Great Depression (Allen, 2011, Mason, 2008).

In response to the crisis there have been wholesale reviews of financial regulation and a reform process that is ongoing and subject to continuing debate. New institutions have been created. For instance, at the international level the G20 government grouping established the Financial Stability Board (FSB) following its London summit in April 2009. The FSB has the task of '*address(ing) vulnerabilities and to develop and implement strong regulatory, supervisory and other policies in the interest of financial stability*'.[1] In Europe a new regulatory architecture termed the 'European System of Financial Supervisors' (ESFS) has been established.

Despite the enactment of new legislations and the establishment of new regulators, plenty of issues still remain to be resolved in the emerging regulatory paradigm. Amongst these is: how can financial innovation be made safe? Accordingly, the Financial Stability Forum, the predecessor to the FSB, recommended that;

> *"Supervisors should see that they have the requisite resources and expertise to oversee the risks associated with financial innovation and to ensure that firms they supervise have the capacity to understand and manage the risks."*(FSF 2008, p.40)

In the context of this recommendation this paper explores two questions;

1. How can the extant literature on the negative impacts of financial innovation help classify, through a taxonomy, the divergent origins, nature and characteristics of the 'dark side' of financial innovation?
2. How can this taxonomy help us understand the types of risk posed by two 'recent' financial innovations (exchange traded funds and high frequency trading)?

With respect to the first research question it is evident that financial innovation has long been a contentious issue (see for example Van Horne, 1985). It is a double edged sword; it can be a force for good but it can also have negative consequences since financial innovations are often associated with financial crises and financial malpractice. Despite commentaries and broad acknowledgment that financial innovation is a double edged sword, the preponderance of formal analyses of financial innovation have, until recently, focused principally on the positive impact of financial innovation (for a review of this literature see Frame and White, 2004). The last few years have, however, seen the emergence of studies on the 'dark side' of financial innovation (for instance Henderson and Pearson, 2011). Accordingly, theoretical and empirical contributions have covered the negative consequences of a range of financial innovations, including structured equity products and credit derivatives. These studies have shed light on the origins, nature and

[1] http://www.financialstabilityboard.org/

differing characteristics of the negative consequences of financial innovations. To the best of our knowledge there have been no prior attempts to summarise this literature and to classify the divergent origins, nature and characteristics of the 'dark side'of financial innovation. Accordingly, the first half of this paper does this by developing a *taxonomy of the 'dark side' of financial innovation.*

With respect to the second research question, the paper applies taxonomy of the 'dark side' of financial innovation to two recent high-profile financial innovations; exchange traded funds (ETFs) and high frequency trading (HFT). Both HFT and ETFs epitomise modern 'high speed' finance. They have been enabled by financial deregulation and by rapid technological change in finance that belies high profile predictions in the 1980s that the pace of technological change and innovation in finance would diminish (Miller, 1986). Both innovations have virtue. HFTs tend to enhance market efficiency by increasing market liquidity. ETFs are cost effective and liquid hedging instruments or investment vehicles. In their role as investment vehicles they allow investors, especially retail investors, the possibility of accessing a much wider range of asset classes than had hitherto been possible, thereby allowing them to benefit from diversification into asset classes that were only available to large institutional investors before. Yet both innovations have, however, been associated with problems in financial markets and have attracted the attention of regulators.

Thus we focus on HFT and ETFs because they are relatively recent innovations and consequently little has been written about them in the academic literature from an innovation-risk perspective (as compared to the innovations associated with the 'credit crunch', such as credit derivatives and mortgage products). Further, as HFT and ETFs have proliferated widely across the financial system in recent years they have become a new source of concern for financial regulator. This is highlighted by two recent high profile 'incidents'; the UBS ETF 'rouge trading' scandal and the '*flash crash*' of 2010 which was associated with HFT.

In the former case, a trader at UBS's Delta One exploited lax settlement practices for synthetic ETF trades to cover his loss making unauthorised trading activity. The incident resulted in an estimated loss of $2.3 billion for UBS. In the latter case, US markets experienced extreme volatility on May 6th 2010, with equity indices losing 5% of their market valued over a 30-minute period. Although the exact cause of the 'flash crash' is a subject of contrasting opinions, many subsequent surveys and reports have blamed the event on "over-reliance on computer systems and HFT" (see Kirilenko et al., 2011:2). Indeed, the volatility attributed to HFT in equity markets has also become an issue in commodity markets as HFT have sought to move into other assets classes (see Diaz-Rainey et al., 2011)

To summarise, the contribution of the paper is twofold. First, we review the emerging literature on the 'dark side' of financial innovation and from this classify the negative effect of financial innovation (The taxonomy). As noted above, to the best of our knowledge this is the first paper to do this. Second, we apply the taxonomy to the cases of HFT and ETFs in order to understand the types of risks these two important 'recent' innovations pose. In order to achieve this, the paper is structured as follows. Section 2 addresses the first research question by developing the *taxonomy of the 'dark side' of*

financial innovation through a review of related literature. Section 3 introduces the two case studies in question (ETFs and HFT). Section 4 tackles the second research question by exploring the nature of the risks posed by HFT and ETF through the lens of the *taxonomy of the 'dark side' of financial innovation*. Section 4 also explores the progress made towards the G20 goal to 'rein in' financial innovation as outlined in the FBS recommendation discussed above. Finally, Section 5 contains a summary and some concluding remarks.

2 Theoretical context: A taxonomy of the 'dark side' of financial innovation

> *"In this address, I wish to consider financial innovation in the good and in the bad. There is much good, as I think we will come to agree. However, some things labelled financial innovations have little or no substance when we peel away the veneer, other than to their promoters"* Van Horne (1985, p.620)

The above quote delivered from the 1984 Presidential Address to the American Finance Association by James C. Van Horne highlights how financial innovation has been a contentious issue for some time. Van Horne (1985) argues that genuine financial innovation is unambiguously a good thing and that it should be distinguished from products and services labelled as such but which are just masked efforts to profiteer from undiscerning clients. As acknowledged by Van Horne (1985), however, distinguishing between the two *ex ante* is not easy. Accordingly, this section explores two related questions: (1) How is financial innovation defined? (2) Can the extant literature on financial innovation help identify the characteristics of 'bad' or 'misused' financial innovations?

2.1 What is financial innovation?

Financial innovation is defined in the literature as the creation and diffusion of new financial instruments, technologies, institutions and markets (Allen and Yago 2010; Tufano 2003). This is a broad and fairly conventional definition of innovation that encompasses the Schumpeterian trilogy of invention, innovation and diffusion. Given the nature of the financial sector, financial innovations can characterised as either

> "*...new products (e.g., adjustable-rate mortgages, exchange-traded index funds); new services (e.g., online securities trading, internet banking); new "production" processes (e.g., electronic record-keeping for securities, credit scoring); or new organizational forms (e.g., a new type of electronic exchange for trading securities, internet only banks)"* (Frame & White, 2004, p.118).

Furthermore, the literature has also sought to understand the 'drivers' or motivation for financial innovation. The most conventional interpretation for the existence of financial innovation is that it comes about as an attempt to overcome market imperfections or inefficiencies in the core activity of finance – that is the allocation of capital spatially, across time and in a world of uncertainty (see Frame & White, 2004, Henderson & Pearson, 2011). Other factors that have been identified in the literature as triggers or

environmental factors driving financial innovation include technological change (especially ICT technologies), regulatory and political changes (such as efforts in the EU to create a single European financial market), changes in taxation, macroeconomic changes (such as globalisation) and intellectual breakthroughs (such as the Black-Scholes derivative pricing model) (see Frame & White, 2004, Tufano, 2003).

2.2 'The dark side of financial innovation'

From the preceding discussion it is clear that the established literature takes a fairly benign view of financial innovation. The logic behind this is that such innovations must be desirable since both the creators/issuers of the innovation and buyers must benefit in some way from the innovation for it to be adopted (otherwise the issuer or the buyer would not pursue the innovation) (Allen, 2011, Henderson & Pearson, 2011). A growing body of literature, however, challenges this rather 'rose tinted' view of financial innovation. Most of this literature highlights the exploitation of behavioural biases and the use of complexity to 'fool' buyers into purchasing inappropriate products or to make them overpay.

In theoretical contributions, Gabaix and Laibson (2006) and Carlin (2009) show respectively that issuers may have incentives to disguise the nature of products so as to exploit customers or to increase complexity so as to make it harder for buyers to make rational choices. The complementary empirical literature has tended to focus on retail consumers. For instance, Ashton and Hudson (2008) building on earlier work by Kahn *et al.*, (1999), show that banks pricing (i.e. the interest rate offered) of deposit accounts and loans are designed to exploit behavioural biases and cognitive limitations such as rounding and truncation. Henderson and Pearson (2011) show that 'structured equity products' (investment vehicles with contingent payoffs) that are popular with US retail investors tend to be 8% overpriced relative to their expected risk/return profile. In analogous research Bergstresser (2008) obtains similar results for a larger sample of equity products from the US, Europe and Asia. Interestingly, Bergstresser (2008) finds that some firms overprice more than others implying that it may not be the innovation that is predatory *per se* but it is its use that is predatory. As Van Horne (1985, p.626) puts it when distinguishing between predatory schemes and abuse of innovations; "*Still other ideas have substance, but the promoters have eaten not only the icing of the cake but also the cake itself*."

The recent credit crunch highlights a second stream to the 'dark side' to financial innovation literature that focuses on the merits or otherwise of credit and credit derivative products.[2] For instance, an exploration by Miles and Pillonca (2008) of the European mortgage market highlights that a lot of recent innovations in the market (lengthened terms and interest only mortgages) served simply to allow consumers to overstretch themselves. This observation is complemented by a number of theoretical papers exploring the potentially negatives welfare effect of credit derivatives. For instance,

[2] See Allen and Yago (2010), Allen (2011), Brunnermeier Brunnermeier, M. K. (2009) "Deciphering the Liquidity and Credit Crunch 2007-2008", *Journal of Economic Perspectives*, Vol. 23, No. 1, pp. 77-100. and Mason Mason, J. R. (2008) "The Summer of '07 and the Shortcomings of Financial Innovation", *Journal of Applied Finance*, Vol. 18, No. 1, pp. 8-15. for general discussions

Morrison (2005) shows that credit derivatives can reduce welfare by reducing incentives for banks to monitor loans, while Duffee and Zhou (2001) show that though individually beneficial, credit default swaps may have the unintended consequence of undermining the loan sales market and thus again reduce welfare.

From a more economy wide perspective, Allen and Carletti (2006) develop a model that shows that a potentially unintended consequence of credit derivatives is that they can increase the likelihood of financial contagion across sectors, and thus lower economic welfare, when financial institutions hold similar assets. Building on this work, Gai *et al.* (2008) show that the combination of financial innovation and greater macroeconomic stability may have made financial crises in developed countries less likely than in the past but potentially more severe.

As a whole, this literature provides an articulate explanation as to why credit and credit derivative innovations did not deliver the risk reductions they promised. More critically the literature highlights that financial innovation that is beneficial in an individual context may not be so beneficial when placed in the broader context i.e. how the innovation interacts with the rest of the financial system may lead to problems and unintended consequences.

2.3. Towards a taxonomy of the dark side of financial innovation

It is safe to say that the credit crunch of 2007-2008 and subsequent economic and financial dislocations have given financial innovation a bad name and have led to calls for it to be 'reined in' (See discussion in *1. Introduction*). The emotiveness that financial innovation engenders has the potential to cloud public policy in this area to be overly intrusive or inappropriate. Accordingly, building on the preceding review and in order to facilitate a more nuanced treatment of financial innovation we develop a taxonomy of the 'dark side' of financial innovation into three categories (1) *predatory schemes* (2) *abuse of financial innovations* (3) *unintended consequence*. In line with Van Horne (1985) all three relate to the application of financial innovation rather than the innovation *per se*. These applications of the innovation can be differentiated in terms of their nature, who can benefit from them, the motivation of their instigators and, consequently, how their negative effects can be mitigated (See Table 1). Prior to a more general discussion of the taxonomy we discuss each component first.

Predatory schemes and associated complexity: This builds on Allen and Yago's (2010) first 'cardinal rule' of financial innovation; namely that complexity should not be confused with innovation. In this context, the creator of 'financial innovation' simply seeks to profiteer from customers, usually by exploiting complexity and cognitive limitations, to deliver a product that has no potential to benefit the customer (See Table 1). Such schemes should be, and often are, outlawed e.g. ponzi schemes. However, there is an identification problem in that predatory schemes may be disguised as genuine innovations through the use of complexity. To overcome this, a licensing type regime for financial innovations could help to disentangle the good from the bad *ex ante*. Indeed, Ashton and Dewing (2011) use a drug licensing analogy to advocate such a regime in financial services. How such a regime would work in practice is difficult to foresee. Further, it could act as a disincentive or 'barrier to entry' to genuine innovations, so more

conventionally such practices are dealt with the enactment and enforcement of laws *ex post.*

Table 1: The Taxonomy and its Application to HFT and ETF

Taxonomy	**Nature of activity**	**Beneficiary**	**Motivation**	**Mitigation**	**Application to HFT (See Section 3.2 & 4.1)**	**Application to ETF (See Section 3.1 & 4.1)**
Predatory Schemes	Innovation is used to commit illegal action or defraud	Asymmetric: Only those creating the scheme can benefit (Predatory)	Profiteering	Licensing of innovations; enactment and enforcement of laws to make the practice illegal; corporate governance	HFT practices of 'spoofing' and 'quote stuffing' to gain unfair advantage over other market participants	Using ETFs for insider trading or unauthorised trading (presumably for personal gain i.e. maintain or increase bonuses)
Abuse of innovation	Innovation is used in an inappropriate or unethical manner (e.g. Mis-selling)	Asymmetric: Value of the innovation goes disproportionately to the creator or seller of the innovation (abusive)	Misplaced incentives; Selling through agents	Conduct of business regulation; corporate governance		Mis-selling of synthetic ETFs to retail customers without explaining associated risks
Unintended consequences	Legitimate use of the innovation, however, interaction of the innovation with the broader financial system or the economy can create problem	Both the creator and purchaser of the innovation have a 'fair' chance of benefitting	Benign (i.e. not abusive or predatory) profit maximising use of the innovation	Licensing of innovations; Policies resulting from independent analysis of systemic implication of new financial innovation	As the flash crash showed the 'benign' presence of HFT in markets can exacerbate and accelerate financial stress	ETFs have been associated with 'speculation' in commodity markets leading to macroeconomic consequence (higher inflation)

Abuse of financial innovations: In this case the financial innovation has merit in that it addresses a market failure or a necessary function of finance (See Section 2.1), however, malfeasance, inappropriate incentives and or low levels of education by sellers may lead to the abuse of the innovation (it's inappropriate use). Good examples of this are self-certification mortgages (where little or no proof of income was needed) which were designed to give the recently self-employed access to housing finance. But advisors sold self-certification mortgages to those employed as a way to get around income multiples restriction on conventional home loans. Moreover these sales agents were principally concerned with their commission and gave little consideration to the suitability of their products. This lead to loans being issued that could not be afforded by their recipients.

These mis-selling problems, which are associated with sales agents faced with inappropriate incentives, have been widely recognised in the finance literature (see for instance (see for instance Black & Nobles, 1998, Inderst & Ottaviani, 2009). Further, they appear to have become more pronounced as finance has moved away from a relationship based model and towards an 'originate and distribute' transactions based model (Brunnermeier, 2009). These mis-selling problems are classic 'conduct of business' financial regulation problems which can generally be overcome by monitoring and compliance (See Table 1). However, in some cases more fundamental regulatory-induced restructuring of business models may be needed to eradicate the most persistent and pronounced inappropriate incentives.

Unintended consequences of financial innovation: In this case, as in the previous one, the financial innovation has merit in that it addresses a market failure or a necessary function of finance but only at the consumer level (the firm or individual purchasing it). At the aggregate level (the financial system; economy-wide), however, the innovation may have damaging unintended and even ultimately welfare destroying consequences (See Table 1). The literature on credit derivatives discussed in *Section 2.2.* eloquently highlighted this possibility – at the firm level they could be used legitimately to hedge or shift risk but at the aggregate they had the impact of augmenting financial contagion. These unintended consequences are arguably the hardest ones for policymakers to deal with for two main reasons.

First, it might involve the difficult task of curtailing or banning innovations that at the individual level have merit. This is likely to make regulators very unpopular and open to accusations of an anti-innovation bias. Second, knowing the unintended consequence *ex ante* may be challenging and open to protracted debate. However, it is noteworthy that the papers by Allen and Carletti (2006), Duffee and Zhou (2001) and Morrison (2005) all pre-dated the credit crunch so at least some researchers were able to see the potential unintended consequences of credit derivatives. Whatever the challenges involved, it is clear that the FSB (2008, p.40) was right to recommend that regulators 'have the requisite resources and expertise to oversee the risks associated with financial innovation' (See *1 Introduction*). Whether this should involve the establishment of new committees, the hiring of new personnel or the development of a licensing regime for financial innovation (see discussion above, Ashton & Dewing, 2011 and Table 1) remains a moot point. (The various interpretations by G20 countries to this FSB recommendation will be discussed in Section 4.2).

The taxonomy of the 'dark side' of financial innovation discussed above can also be understood by way of analogy with illegal recreational and prescription drugs use – In this we were inspired by Ashton and Dewing (2011)'s related medical analogy. *Unintended consequence* can be seen as unanticipated side effect from a prescription drug that cures a well diagnosed illness. *Predatory Schemes* could be viewed as analogous to the use of illegal recreational drugs. Users may feel good temporarily but ultimately the only winner is the 'pusher' of the drugs. *Abuse of innovation* could be seen as analogous to the use or abuse of prescription drugs for recreational purposes or the overmedication of patients by doctors whom are over-incentivised by pharmaceutical companies.

In the case of drugs, legislation and regulation can curtail illegal drug use and the abuse of prescription drugs, but it cannot eliminate it entirely. This is likely to be true of the dark side of financial innovation and calls for a wider examination of the context and motivations driving the undesirable consequences. There appears to be no literature that explicitly addresses the motivation question in the context of financial innovation, nevertheless the literature on white collar and financial crime may have some useful lessons (see for instance Hansen, 2009, Nie, 2009, Tibbs *et al.*, 2011). Clearly the main reason for predatory schemes and abuse of financial innovation is personal gain in some way (See Table 1). Interestingly, Tibbs *et al.* (2011) investigate the return effect of corporate misconduct and find a net benefit to shareholders from misconduct (i.e. the positive abnormal stock returns during the pre-discovery period are only partially reversed during the post-discovery period). Their evidence points to the need to ensure that punishment for undesirable behaviours are punitive enough to more than cancel out ill-gotten gains. This should apply to individual gains just as much as it should apply to firm profits and would accordingly ensure a strong future disincentive. On the more general corporate governance side Nie (2009) finds that firms not involved in securities fraud (versus those that were) tended to have more outsiders on their boards, the management teams had longer tenures and were more likely to own equity in the business. These insights point to corporate governance considerations (see Table 1 and Hansen, 2009) being an important and complementary weapon to regulatory efforts (including punitive sanctions) in the 'war' against the dark side of financial innovation.

3 Case Studies: Exchange Traded Funds and High Frequency Trading

This section contains the case studies of two relatively recent financial innovations; ETF and HFT. For each we provide a description of the innovation and examples of associated risks. This overview of ETFs and HFT will allow for a discussion of their regulatory implication in Section 4.

3.1 Exchange Traded Funds

ETFs constitute an alternative form of investment; they track market indexes by replicating an index basket. ETFs are not perfect substitutes for conventional open-ended index funds such as unit trusts or mutual funds (see Agapova, 2011). As physical ETFs usually hold only a weighted representative sample of the index they track and are traded like stocks on exchanges (akin to close-ended funds like investment trusts), they provide a level of diversification similar to mutual funds while retaining the immediacy of transactions (liquidity) and lower trading costs of exchange traded securities (see among

others Boehmer & Boehmer, 2003, Deville, 2008, Gastineau, 2002, Gastineau, 2004). Thus ETFs can be used as cost effective and liquid hedging instrument or investment vehicles. In the latter case in particular, they allow retail investors access to a wider range of assets classes, thereby allowing them to potentially benefit from diversification into asset classes hitherto unavailable to them. From a risk perspective well-diversified physically delivered ETFs should pose no bigger risk to the financial system than the indexes they track. However, the pace of innovation in financial services, as well as liberal regulatory environment in Europe, has led to the development of a riskier ETF, the so-called "synthetic" ETFs.

Synthetic ETFs provide returns relative to indexes as well but do not reconstitute the indexes they track; instead they execute an OTC (Over-the-Counter) derivatives asset swap with a counterparty who undertakes to provide the index returns. According to a report of the Financial Stability Board (FSB, 2011), in Europe, they currently account for about 45% of the ETF market, fuelled by the fact that derivatives desks of large banks can act as counterparties to the investment or asset management divisions of the same banks selling ETF. Physical ETFs do not always deliver promised index return due to tracking error related to the cost of trading the underlying securities while synthetic ETFs offer the potential to perfectly match the index. This potential performance and hedging superiority of synthetic ETFs comes at the cost of counterparty risk i.e. the risk that the counterparty promising to deliver the index return becomes insolvent. Further, the risks posed by synthetic ETFs are larger in that they can potentially encourage the matching of securities with differing (inferior) liquidity - an issue that may only become apparent during financial turmoil when less liquid assets tend to be sold at deep discounts. The IMF has been keen to highlight that this practice poses risks of systemic proportions to the financial sector.[3]

Other issues causing regulators to be concerned about ETFs generally include securities settlement practices, the use of leverage and the creation of ETFs investing in other asset classes, including debt and commodities.

Examples of Associated Risks

The recent rogue trading scandal at UBS's Delta One derivatives desk highlighted the lax settlement practices in ETF trading in Europe. The trader involved, Mr. Kweku Adoboli had exploited the lax settlement requirements for synthetic ETF trades to cover his loss making investments far longer than should have been possible in today's lightening fast financial transactions environment. The unauthorised trading activity led to a loss of an estimated $2.3 billion for UBS. Mr. Adoboli's loss making trades were not ETFs, however, he took advantage of the fact that synthetic ETF trades in Europe can be settled after the conventional three day lag required for most derivative trades, to set up spurious forward settling cash ETF positions as a hedge against his original bets. Also, the trades do not have to be confirmed until settlement; hence proceeds from these trades can be

[3] 'IMF raises concerns about ETF systemic risks' *Financial Times*, 13 April 2011. Available from http://www.ft.com. Accessed 10/12/11.

acknowledged on a trader's books as if they have in effect been delivered in anticipation of the delivery.[4]

The UBS scandal is not the only instance of impropriety involving ETFs. According to Conroy *et al.* (2011), a former Goldman Sachs trader has recently been accused of insider trading in regards to ETFs. Traders can exploit private information to indulge in *ETF stripping*, taking long (short) positions on specific constituent stocks of ETFs based on the information they hold. A further concern is that the creation of commodities ETFs is contributing to 'speculation' in commodities markets leading to inflated prices of basic commodities such as food and energy (see amongst others Diaz-Rainey *et al.* 2011).

As noted earlier, despite these problems the open-ended (potential for low cost diversification) and close-ended (high liquidity) features of ETFs make them attractive investment vehicles and hedging instruments (see Fuller, 2008), hence their continued growth. Growing at an estimated annual rate of 40%, the global ETF market in 2010 surpassed the 1 trillion dollar mark (FSB, 2011). The market has progressed in both complexity and diversity, with several variants of the original fund being floated. There are now leveraged, inverse and leveraged-inverse ETFs as well as ETF-styled debt securities, Exchange Traded Notes (ETNs) and Exchange Traded Vehicles ETVs (FSB, 2011). Recent events, growing product complexly, the risk of contagion effects and the uncertainty about interactions with other financial innovations (e.g. algorithmic trading) all underscore the heightened concerns of regulators about ETFs.

3.2 High Frequency Trading

Technological improvements and innovations in financial market trading platforms since the late 1980s have gradually altered the way markets operate and how prices of securities are determined. Technology is now a very important determinant of asset price discovery process (see among others Barclay & Hendershott, 2003, Barclay *et al.*, 1990, Chan *et al.*, 1995, Easley *et al.*, 1996, Easley *et al.*, 1997, Flood *et al.*, 1999, Hendershott *et al.*, 2011, Hendershott & Riordan, 2011). The advent of high frequency trading/traders (HFT) or *algorithmic trading (AT)* has seen the gradual erosion of the classic floor trading by computer algorithm controlled trading. The algorithm has now replaced the judgement of the floor trader, previously coveted in the execution of limit orders in order to avoid driving prices ('moving the market') as a result of his or her trades. Algorithms now determine the optimal conditions for executing trades, this includes, the quantity to execute, the venue, the timing and order routing. This is done while constantly monitoring market environment across many platforms, securities and their limit order book, to guard against them becoming stale.

Hendershott *et al.* (2011) suggest that the introduction of HFT has improved trading quality through decline in trading (including adverse selection) costs and improved informativeness of quotes. These effects of algorithmic trading have resulted in the enhancement of liquidity over time on most platforms. The positive impacts of HFT on

[4] For more details see 'The fine line between bad luck and rogue trades', *CNN Money*, 27 September 2011 (Available from http://money.cnn.com/magazines/fortune/ Accessed 10/12/11.) and 'Delta One forced out of the shadows' and 'UBS trader Adoboli held over US$2bn loss', *Financial Times*, 15 September 2011 (Both available from http://www.ft.com. Accessed 10/12/11.)

liquidity provision are such that market inefficiencies are far less common. Daily serial correlations on platforms with HFT activity have seldom been more than zero and short-horizon deviations from random walk benchmarks are quite rare. Increasingly, markets are now reliant on HFT systems as market makers; however, these systems do not conform to the traditional norms of market making (see Easley *et al.*, 2011, Kirilenko *et al.*, 2011, Menkveld, 2011).

Examples of Associated Risks

For all the advantages of seeding control of trading decisions to algorithms, there are fundamental shortfalls of the system as well. No event illustrates this point better than the extreme volatility event of May 6th 2010, the so-called '*flash crash'* (see Easley *et al.*, 2011, Kirilenko *et al.*, 2011). During a 30-minute period on that day, U.S. equity indices had about 5% of their market value wiped-out, only to rebound after the half-hour period. According to CFTC-SEC (2010) report on the event, many of the nearly 8,000 stocks and ETFs trading on the day were affected by the wild swing. Surveys conducted since then have blamed the event on "over-reliance on computer systems and HFT" and many believe this could happen again (see Kirilenko et al., 2011:2).

HFT generates massive amounts of liquidity for U.S. platforms. On 6th May 2010, according to CFTC-SEC (2010), reductions in liquidity induced execution of trades at preposterous prices, some as high as $100,000.00 and others as low as 1cent a share. At the time of the crash, U.S. securities indices were already down over 4% on the day creating a rather volatile and uncertain trading environment. It was in this environment that a fundamental trader decided to execute a 75,000 E-mini contract (worth about $4.1 billion) sell order. The algorithm used was programmed to target volume and not price or time. The order executed rapidly in 20 minutes, triggering a series of intensive liquidity driven HFT trading manoeuvres which led to the flash crash. Two orders of similar sizes within the 12 months preceding 6 May, 2010 had taken about five hours to execute, using a combination of manual and algorithms targeting volume, price and time.

Easley *et al.* (2011), take a narrower microstructure view of the crash, attributing it to market toxicity (anticipated losses attributable to adverse selection costs) arising as a result of loss of market liquidity. Programmed market makers, taking very low inventory positions as a hedge against inventory costs, when confronted with order flow toxicity, will attempt to cut their losses by liquidating their assets, hence turning into consumers of liquidity rather than providers. With liquidity gone, and a programmed goal of cutting losses, the programmes traded at best market prices, hence the flash crash. Kirilenko *et al.* (2011) agree that HFT traders aggressively mopped up liquidity to retain target inventory levels during the crash; they suggest that this trading pattern aggravated the wild swing in prices. They disagree with the CFTC-SEC (2010) report on the role of HFT algorithms in the crash. While HFT activity worsened the situation, it could not have triggered it without changing their already programmed trading strategies.

Irrespective of the views of sources on the event of 6th May, one thing is clear, high frequency traders contributed in some way to the flash crash, and this can happen again. In no way should the short-term liquidity they provide be misconstrued as helping to smooth out volatility. Volatility grows with growing HFT activity (see Brogaard, 2011,

Zhang, 2010). The volatility attributed to HFT in equity markets has also become an issue in commodity markets as HFT have sought to move into other assets classes (see Diaz-Rainey et al., 2011 and Footnote 8). Further, regulators have become concerned with manipulative practice by HFT such as 'layering', 'spoofing' and 'quote stuffing'.[5] These practices potentially disrupt pricing efficiency and are thus dimly viewed by the authorities. For example, spoofing which involves submitting bids and offers with the absolute intention to cancel them before execution, tampers with the price discovery process. Since the price formation process is dependent on orderflow, a compromised order process reveals an inaccurate aggregation of trading intentions. The Dodd-Frank legislation thus empowers the CFTC to make regulations to discourage practices such as spoofing.

4. Application of the taxonomy: Regulatory implications of HFT and ETF

As noted in the *Introduction*, both HFT and ETFs epitomise modern 'high speed' finance. They have been enabled by financial deregulation and by rapid technological change in finance. Both innovations have virtue; they offer potential societal benefits in terms of greater market efficiency (HFT) and more effective diversification (ETFs) yet as noted in the preceding discussion both innovations pose considerable and contrasting risks. Accordingly, Section 4.1 articulates these risks through the lens of the taxonomy of the 'dark side' of financial innovation developed earlier. Section 4.2 draws on a G20 survey of member countries to discuss the ability/capabilities of financial regulators to deal with the risks associated with financial innovation.

4.1 The 'dark side' of HFT and ETFs

It is evident that both HFT and ETF are complex financial innovations. ETFs are an example of a product innovation while HFT can best be understood as a disruptive innovation that is both a new production process and new organisational form (See Frame and White, 2004 and Section 2.1). The complexity of both innovations mean variants of them might be constructed so as to create *predatory schemes* (see Table 1). The use of ETFs to conceal insider dealing and HFTs for 'spoofing' other computers into trading losses are relevant examples of how both innovations can be used to create predatory schemes (See Sections 3.1 and 3.2 respectively). The latter case in particular shows the challenges regulators face in detecting predatory schemes. Determining whether an algorithm is predatory is extremely difficult given the speed of trading, the proliferation of alternative trading venues and since HFT firms guard their algorithms jealously (they are after all their competitive *raison d'être*).[6] Such challenges call for enhanced market

[5] Layering, spoofing and quote stuffing all refer to order placement practices aimed at gaining fraudulent advantage over other traders. Layering involves submitting orders aimed at baiting simulated reactions from other trading algorithms; the elicited reactions are aimed at providing arbitrage opportunities. Quote stuffing refers to flooding of the exchange with orders which are quickly pulled to gain a price edge over rivals by slowing their computers down.

[6] See for instance 'High-frequency trading raises concerns at SEC', *Washington Post*, 22 February 2012 (Available www.washingtonpost.com from. Accessed 07/03/12.) and 'Subpoenas Go Out to High-Speed Trade Firms', *The Wall Street Journal* 8 August 2011(Available from www.wsj.com Accessed 07/03/12.)

monitoring capabilities and perhaps new powers (for instance the right to inspect algorithms or have algorithms approved or licensed prior to deployment).

With ETFs there is a clear danger of *abuse of financial innovation* occurring. This is common in financial innovations that have genuine merit and can be sold to retail investors (see Table 1). Influential industry insiders have vocally expressed that ETFs, and especially synthetic ETFs, are being mis-sold to retail investors whom have poor or no appreciation of the risk involved in their investment (this is particularly true if counterparty risk becomes an issue for a synthetic ETF).[7] There is a danger here that *predatory* and mis-sold (i.e. *abuse of financial innovation*) ETFs could undermine ETFs more generally. The issue seems to be particularly acute in Europe because there is a more liberal approach to what can be contained in collective investment vehicles relative to the US. Hence in Europe the relevant regulation allows ETFs to use derivatives within certain limits for both hedging and investment purposes (FSB, 2011). In response to these concerns ESMA, one of the new European-wide financial regulators discussed earlier, has recently issued a discussion paper to explore the risk associated with the selling of complex ETFs to retail investors as part of its role of monitoring the impact of financial innovation on financial markets (ESMA, 2011).

How effectively ESMA will be able to identify and mitigate associated risk in the context of a single European market for financial services that spans multiple languages and national jurisdiction remains a moot point. The rogue trading scandal at UBS's Delta One derivatives desk, where lax settlement practices in ETF trading in Europe were exploited, highlights how regulations and regulators have found it difficult to keep up with rapid innovation in the ETFs market. This once more highlights the issue of adequate regulatory resources to understand and monitor the risks associated with financial innovation.

Finally, both ETFs and HFTs pose risks in terms of the *unintended consequences of financial innovation* (see Table 1). One example has been already alluded to in Section 3.1; namely that investment in commodities ETFs could contribute to a spike, for example in energy prices, with negative macroeconomic consequences. Another possibility relates to the interaction of HFT and ETFs and systemic risk. The collapse of a major Synthetic ETF swap counterparty (usually an investment bank) could lead to the sale of ETFs and in the underlying markets they track (equities, debt securities or commodities) that might be amplified or accelerated by HFT. The intervention of HFTs would narrow the window of opportunity for regulators and central banks to intervene to avoid widespread contagion.[8]

Indeed the 'flash crash' underscored how dependent the markets have become on HFT for price discovery and therefore how HFT can exaggerate market crashes by

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[7] 'Trillion-dollar danger of 'untested' funds', *The Guardian*, 16 December 2011, p.36

[8] A recent example of the interaction between HFT and ETFs was the spike in oil prices and associated market uncertainty caused by a trading algorithm going wrong at Infinium Capital Management. The algorithm exploited arbitrage opportunities between an oil ETF and the oil futures market. See 'Exclusive: Firm faces civil charges for U.S. oil trading mayhem', *Reuters*, 25 August 2010, Available from http://hft.thomsonreuters.com/. Accessed 15/12/11.

withdrawing liquidity (something they are fully entitled to do as they have no obligation to make markets) during times of financial stress (See Section 3.2 and Table 1). In response to such systemic fears, the recently proposed revision to the Markets in Financial Instruments Directive (known MIFID II) seeks to formally regulate HFT in Europe to ensure they have adequate risk management measures in place, they provide liquidity irrespective of market conditions and their actions are transparent. Further, there is currently a proposal in Europe to introduce a financial transactions tax that could, depending on its size, drive HFTs out of the market since they make their profits from high speed, high volume but low margin trades. This may mitigate some of the risk associated with HFT but it may come at too high a cost since, as noted earlier, the emergence of HFT has contributed to the provision of liquidity and by extension market efficiency. High frequency traders/algorithmic traders can be vigilant market participants and can therefore identify deviations from underlying worth. The issue is therefore, how to harness the positive aspects of this HFT and tame its negative consequences? In this respect it will be interesting to see how MIFID II will seek to ensure that HFT provide liquidity irrespective of market conditions.

Limitations of time, space and resources meant that from the short proceeding discussions detailed policy recommendations with respect to HFT and ETFs could not, and should not, be made. These are complex innovations with related regulations subject to protracted consultations which are in turn associated with intense lobbying and difficult trade-offs. Moreover, both innovations are continuing to evolve rapidly so a more pertinent question in the more general endeavour of this paper (of developing a taxonomy of the dark side of financial innovation) is whether regulators have the ability to deal with the negative consequences of financial innovations as these innovations emerge and evolve.

4.2. Mitigating the risk of financial innovation: Evidence from the G20

These cases HFT and ETF do highlight that, as recommended by the G20 and the Financial Stability Board, countries need to ensure that financial regulators 'have the requisite resources and expertise to oversee the risks associated with financial innovation' (see FSF, 2008 and *1. Introduction*). This recommendation eventually became one of the various reform recommendations that the FSB has been monitoring through the FSB Implementation Monitoring Network which surveys G20 member's progress on reforms. *Table 2* provides a summary of a selected group of G20 countries self-reported progress towards achieving this particular goal.

From *Table 2* it is clear that efforts to strengthen regulatory capabilities with respect to financial innovations are at an early stage of development and have been subject to differing interpretations amongst G20 member countries. For instance, some countries have emphasised recruitment and training of supervisory staff (Germany, Italy, Japan, Spain and the UK) while others have established new committees or departments to deal specifically with financial innovation or new financial products (China, France, the EU and the Netherlands). Further highlighting differences some countries interpret the FSB/G20 recommendation as an issue related to banking (Italy) while other countries emphasise the risks to retail investors (France) or emphasised macro-prudential risks

(Japan). Since risks from financial innovation are relevant to all of these, there appears to be a failure to address the issue in a thematic and comprehensive manner.

Arguably the most robust efforts to establish dedicated capabilities to address risks from financial innovation have been at the EU level. As noted in the *Introduction*, in Europe a new regulatory architecture termed the 'European System of Financial Supervisors' (ESFS) has been established. The ESFS includes three new Europe-wide regulators for banking (the European Banking Authority or EBA), insurance and pensions (European Insurance and Occupational Pensions Authority or EIOPA) and for financial markets (European Securities and Markets Authority or ESMA).[9]

The EU has required its three new EU-wide regulators (EBA, ESMA and EIOPA) to establish committees to monitor financial innovation. As a result, ESMA has established the Financial Innovation Standing Committee and EIOPA has set up the Committee on Consumer Protection and Financial Innovation. Further, the EU claims to have the powers to prohibit or temporarily ban innovations that 'threaten the orderly functioning and integrity of financial markets or the stability of the whole or part of the financial system in the EU' (See *Table 2*). The US's unenlightening response of "on-going" in its response to the G20 survey on this goal might hint at a lack of co-ordination, impetus or specific focus amongst US policymakers.

It should be noted, however, that *Table 2* only presents the evidence for a selected group of G20 countries and presents the countries self-reported responses to one of many questions related to regulatory reform in the context of a whole host of FSB/G20 recommendations. There is, therefore, a need to analyse these responses in a more systematic fashion and in the context of wider reform initiatives. The evidence presented in *Table 2* would suggest, however, that the FSB/G20 recommendation with respect to financial innovation has not been central to governments' efforts to reform the financial architecture. This is surprising since, as noted in the *Introduction*, risks associated with financial innovations were identified as one of the principal culprits in creating the 'credit crunch' and subsequent economic malaise.

[9] In addition, there is also a European Systemic Risk Board (ESRB) under the responsibility of the European Central Bank tasked with macro-prudential oversight of the EU financial system. These new institutions are to co-ordinate regulatory efforts with domestic regulators and represent a major shift in regulatory power toward EU institutions.

Table 2. G20 Resources and Expertise to Oversee the Risks of Financial Innovation for Selected Countries[10]

Country	Progress to date
China	The China Banking Regulatory Commission (CBRC) has established a department to regulate financial innovation and made it clear that commercial banks should be well informed of their counterparties, businesses and risks, and estimate related costs. The CBRC has issued rules on conducting prudential regulation over specific businesses, to guide banking financial institutions, including the Guidance on Financial Innovation of Commercial Banks and Guidance for Supervision and Management of Asset Backed Securitisation. In accordance with the Securities Law and the Regulation on the Supervision and Administration of Securities Companies, the China Securities Regulatory Commission (CSRC) fulfils the responsibility of supervision and administration of securities companies. Securities companies and their domestic subsidiaries shall not be engaged in a certain business unless approved by the CSRC. In order to effectively control risks, the financial innovation of securities companies should also be supervised by the CSRC.
France	The AMF has also established a new Retail Investors Relations Division in charge of monitoring marketing campaigns and new products being offered to investors. Specific attention is being devoted to complex products. The AMF is also taking actions, in application of the Undertakings for Collective Investment in Transferable Securities (UCITS) directive and later of the AIFM directive, to ensure fund managers have sufficient resources and valuation tools to correctly understand and control the risks associated with investment strategies.
Germany	BaFin and Deutsche Bundesbank have implemented personnel policies allowing the recruitment of highly qualified supervisors. They provide and permanently develop training programs. BaFin and Bundesbank have, for example, initiated in 2009 a European-wide training network called the "European Supervisor Education Initiative". With regard to institutions, German supervisors require firms to have adequately trained and experienced staff with regard to their competencies and responsibilities within the firm. This requirement is part of the Supervisory Review and Evaluation Process assessment. The existent supervisory standards already provide for measures to ensure that firms only invest in products if they have the capacity to understand and manage the associated risks.
Italy	The Bank of Italy stuck to its efforts to improve its staff expertise in risk oversight. Overall, about 1,700 personnel units – equal to 3,800 working days – attended training initiatives focused on: procedures for the assessment of intermediaries' risk profile; methods for the analysis of the ICAAP produced by the intermediaries; recent changes in the reporting system. Where necessary, banks are formally warned and urged to take prompt corrective actions. Supervisory meetings with the bank management (e.g. CEO, Audit, Risk Management etc) or, if deemed appropriate, inspections may be arranged. An extensive training programme focused on Solvency II issues is underway. It includes a basic course on fundamental issues as well as an advanced course for actuaries and other skilled staff.

[10] Compiled from G20 country responses to Question 12 of survey monitoring progress made in implementing recommended reforms. Submitted to the G20 Cannes Summit in November 2011. See http://www.financialstabilityboard.org/publications/r_111104.htm Accessed 9/12/2011.

Japan	The Financial Services agency (FSA) established a specialized office that collects and analyzes information related to financial system risks and is trying to advance risk analysis. Besides cultivating and utilizing staffs' expertise internally, the FSA and Bank of Japan (BOJ) have employed professionals actively from the private sector (including system/market risk experts, actuaries, lawyers and public certified accountants) In order to respond properly to sophistication and complication of financial activities, the FSA and BOJ have conducted effective and efficient inspection and/or the supervision through collecting information and analyzing the condition of the macro economy and each market such as the stock or bond market in addition to employment and cultivation of staff with a high level of expertise. The FSA and BOJ believe that these efforts had certain effects on encouraging financial institutions to enhance their risk management.
Netherlands	In its supervisory approach, De Nederlandsche Bank (DNB) has enlarged its focus to address governance and business models of financial institutions, including evaluations of suitability of board members and board effectiveness. The EBA has set up a permanent committee to discuss and evaluate financial innovation.
Spain	Spanish approach to financial supervision is its proximity close and intensive. Supervisory staff includes lawyers, economists, accountants, and other experts in specific banking areas (risk models, IT systems…). There is in place a rigorous program of ongoing education.
Switzerland	Swiss Financial Market Supervisory Authority (FINMA) is operating qualified and experienced risk departments directly overseeing the risk of large banks and insurances. Other institutions are covered by an early warning system as described below and are regularly reviewed by external auditors directly reporting to FINMA (dualistic supervision). The procedure proved to be effective. It helps to concentrate supervisory resources, while at the same time making sure that issues get recognized and addressed within the continual supervision process.
United Kingdom	The Financial Services Authority's (FSA) continue to focus on the recruitment and retention of high-quality staff. The average number of full-time equivalent employees for 2011/10 was 3,291, up from 2,952 during the previous period. This increase in resources is associated with a revised regulatory philosophy and operating model. The new, outcomes-based approach recognises that the FSA will intervene in a proactive way when it believes that the results of a firm's actions will pose risks to its statutory objectives. In its June 2011 consultation document, the Government set out further detail of plans to create a Prudential Regulation Authority (PRA), to ensure that a new, more judgement-focused approach to regulation of firms is adopted so that business models can be challenged, risks identified and action taken to preserve stability. The Bank of England and the Financial Services Authority have published two documents setting out further information about the PRA's proposed approach to banking supervision (May 2011) and insurance supervision (June 2011). The Government aims to ensure the passage of the necessary primary legislation in 2012.
United States	Ongoing
European Union	Creation of the three supervisory authorities in the EU. These are obliged to monitor new financial products, and create a committee on financial innovation, which brings together all relevant competent national supervisory authorities with a view to achieving a coordinated approach to the regulatory and supervisory treatment of new or innovative financial activities. They may also temporarily prohibit or restrict certain financial activities that threaten the orderly functioning and integrity of financial markets or the stability of the whole or part of the financial system in the EU.

5 Conclusions

The first half of this paper developed a taxonomy of the 'dark side' of financial innovation that categorised the negative effects of financial innovation as (1) *predatory schemes* (2) *abuse of financial innovation* and (3) *unintended consequences of financial innovation*. The contribution of the taxonomy is to facilitate a more nuanced treatment of the negative consequences financial innovation. In the second half of the paper, the taxonomy was applied to the cases of two recent financial innovations (exchange traded funds or ETFs and high frequency trading or HFT) that have attracted interest from financial regulators who are concerned by the risk they may pose to the financial system and to the orderly operation of financial markets. We explored these risks with examples and in the context of current efforts to reform financial regulation following the 2007-2008 'credit crunch'. In the latter case, we drew on a G20 survey that explored the capabilities of regulators to mitigate the negative effects of financial innovation.

Overall, we concluded that both innovations are genuine innovations that offer potential societal benefits of greater market efficiency (HFT) and more effective diversification (ETF); however, both innovations pose considerable and contrasting risks. A limitation of our research is that a qualitative analysis like this cannot yield answers as to whether the negative aspects of EFT and HFT outweigh the positives. Accordingly, the paper does not suggest that these innovations fall or don't fall on the 'dark side' of financial innovations in some type of dichotomous rule. The taxonomy does, however, help us identify the types of risks that may arise from these innovations.

With respect to ETFs all three components of the taxonomy were relevant but perhaps the ones that should have the greatest risk weighting related to *abuse of innovation* (i.e. the apparent mis-selling of synthetic ETFs to retail customers without explaining associated risks) and *unintended consequences* (their implication for speculation in commodity markets and in terms of contagion in times of financial stress) (see Table 1, Section 3.1. and Section 4.1). In terms of HFT, two of the components of the taxonomy are relevant: *predatory schemes* and *unintended consequences* (see Table 1, Section 3.2. and Section 4.1). In the former case, regulators are clearly concerned about practices such as 'spoofing' and 'quote stuffing' but are finding it difficult to identify concrete cases and take mitigating actions given current resource constraints and powers. In the latter case, it is clear that market efficiency/liquidity benefits of HFT come at a price. The price is higher volatility especially during times of financial stress as epitomised by the 'flash crash'. By ensuring HFT provide liquidity to the market irrespective to market conditions, the EU's proposed reform of the MIFID regulation purports to harness the positives and eliminate the negatives of HFT. How this is actually going to be achieved, in the context of increasingly integrated international financial markets, remains to be seen.

Limitations of time, space and resources meant that detailed policy recommendations with respect to HFT and ETFs were not made. As noted earlier these are complex innovations that are evolving rapidly, so it is unsurprising that related regulations are subject to protracted consultations with intense lobbying and difficult trade-offs. The case

studies of HFT and ETF do, however, appear to vindicate the recommendation by the G20 and the Financial Stability Board that countries need to ensure that financial regulators 'have the requisite resources and expertise to oversee the risks associated with financial innovation' (see FSF, 2008 and *1. Introduction*). The analysis of the G20 survey of regulatory capabilities discussed in Section 4 and depicted in *Table 2* highlights differing concerns and emphases about the risks posed by financial innovation among the G20 member countries. More generally, the evidence presented in *Table 2* would suggest that the FSB/G20 recommendation with respect to financial innovation has been given a low priority by member countries or is not being tackled in a thematic and comprehensive fashion. However, as noted earlier, *Table 2* only provides a snapshot of what is going on in reform processes so there is a need for further research to ascertain exactly what countries are actually doing to tackle the 'dark side' of financial innovation.

Finally, even though enhanced regulatory capabilities with respect to the negative aspects of financial innovation are clearly desirable, they should not be seen as the only avenue to mitigating these risks. The literature on white collar and financial crime suggests that corporate governance considerations represent a complementary approach to mitigating the negative consequences of financial innovation (see Section 2, Hansen 2009; Nie 2009). In particular, Nie (2009)'s results (that firms not involved in securities fraud, versus those that were, tended to have more outsiders on their boards, the management teams had longer tenures and were more likely to own equity in the business) suggest that a lot can be done at the firm level to ensure individual firms employ financial innovations in a responsible, ethical and law-abiding manner.

Nie (2009)'s research, however, was not specifically focussed on financial services firms, nor was it framed within the context of financial innovation. Accordingly, there is a clear need to explore whether these findings are still valid in this more specific context. Other avenues for further research are also apparent from the preceding discussions. There is clearly a need to survey retail ETF investors to assess the degree to which they understand the risks they are taking, especially in terms of synthetic ETFs. In addition, modelling or simulation of the interaction between ETFs and HFT in times of financial stress and across multiple asset classes will allow for a better understanding of possible unintended consequences of the 'fusion' of the two innovations (See Section 4.1).

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References

Agapova, A. (2011) "Conventional mutual index funds versus exchange-traded funds", *Journal of Financial Markets*, Vol. 14, No. 2, pp. 323-343.

Allen, F. (2011) "Trends in Financial Innovation and Their Welfare Impact: An Overview", *SSRN eLibrary Working Paper*.

Allen, F. and E. Carletti (2006) "Credit risk transfer and contagion", *Journal of Monetary Economics*, Vol. 53, No. 1, pp. 89-111.

Allen, F. and G. Yago (2010) *Financing the Future: Market-Based Innovations for Growth*, Pearson Education, Upper Saddle River, NJ.

Ashton, J. K. and I. Dewing (2011) "Tackling the wider issues of mis-selling", in, *FS Focus*, Financial Services Faculty.

Ashton, J. K. and R. S. Hudson (2008) "Interest rate clustering in UK financial services markets", *Journal of Banking & Finance*, Vol. 32, No. 7, pp. 1393-1403.

Barclay, M. J. and T. Hendershott (2003) "Price Discovery and Trading After Hours", *The Review of Financial Studies*, Vol. 16, No. 4, pp. 1041-1073.

Barclay, M. J., R. H. Litzenberger and J. B. Warner (1990) "Private Information, Trading Volume, and Stock-Return Variances", *The Review of Financial Studies*, Vol. 3, No. 2, pp. 233-253.

Bergstresser, D. (2008) 'The retail market for structured notes: Issuance patterns and performance, 1995-2008', Harvard Business School, Boston MA.

Black, J. and R. Nobles (1998) "Personal Pensions Misselling: The Causes and Lessons of Regulatory Failure", *The Modern Law Review*, Vol. 61, No. 6, pp. 789-820.

Boehmer, B. and E. Boehmer (2003) "Trading your neighbor's ETFs: Competition or fragmentation?", *Journal of Banking & Finance*, Vol. 27, No. 9, pp. 1667-1703.

Brogaard, J. (2011) "High Frequency Trading and Volatility", *SSRN eLibrary Working Paper*.

Brunnermeier, M. K. (2009) "Deciphering the Liquidity and Credit Crunch 2007-2008", *Journal of Economic Perspectives*, Vol. 23, No. 1, pp. 77-100.

Carlin, B. I. (2009) "Strategic price complexity in retail financial markets", *Journal of Financial Economics*, Vol. 91, No. 3, pp. 278-287.

CFTC-SEC (2010) *Findings Regarding the Market Events of May 6, 2010*. Report for Joint Advisory Committee on Emerging Regulatory Issues: Washington.

Chan, K. C., W. G. Christie and P. H. Schultz (1995) "Market Structure and the Intraday Pattern of Bid-Ask Spreads for NASDAQ Securities", *The Journal of Business*, Vol. 68, No. 1, pp. 35-60.

Conroy, P., J. Overdahl, R. Patton and R. Wong (2011) *ETFs: Overview and Recent Issues.* Report for NERA Economic Consulting: New York.

Deville, L. (2008) 'Exchange Traded Funds: History, Trading and Research', in C. Zopounidis, M. Doumpos & P. Pardalos (Eds.): *Handbook of Financial Engineering*, pp. 1-37, Springer, Berlin Heidelberg.

Diaz-Rainey, I., M. Siems and J. Ashton (2011) "The Financial Regulation of Energy and Environmental Markets", *Journal of Financial Regulation and Compliance,* Vol. 19, No. 4, pp. 355-369.

Duffee, G. R. and C. Zhou (2001) "Credit derivatives in banking: Useful tools for managing risk?", *Journal of Monetary Economics,* Vol. 48, No. 1, pp. 25-54.

Easley, D., N. M. Kiefer and M. O'Hara (1996) "Cream-Skimming or Profit-Sharing? The Curious Role of Purchased Order Flow", *The Journal of Finance,* Vol. 51, No. 3, pp. 811-833.

Easley, D., N. M. Kiefer and M. O'Hara (1997) "One Day in the Life of a Very Common Stock", *The Review of Financial Studies,* Vol. 10, No. 3, pp. 805-835.

Easley, D., M. M. Lopez de Prado and M. O'Hara (2011) "The Microstructure of the "Flash Crash": Flow Toxicity, Liquidity Crashes, and the Probability of Informed Trading", *Journal of Portfolio Management,* Vol. 37, No. 2, pp. 118-128.

ESMA (2011) *ESMA's policy orientations on guidelines for UCITS Exchange-Traded Funds and Structured UCITS.* Report for European Securities and Markets Authority: Paris.

Flood, M. D., R. Huisman, K. G. Koedijk and R. J. Mahieu (1999) "Quote Disclosure and Price Discovery in Multiple-Dealer Financial Markets", *The Review of Financial Studies,* Vol. 12, No. 1, pp. 37-59.

Frame, W. S. and L. J. White (2004) "Empirical Studies of Financial Innovation: Lots of Talk, Little Action?", *Journal of Economic Literature,* Vol. 42, No. 1, pp. 116-144.

FSB (2011) *Potential Financial Stability Issues Arising from Recent Trends in Exchange-Traded Funds (ETFs).* Report for Financial Stability Board.

FSF (2008) *The FSF Report on Enhancing Market and Institutional Resilience.* Report for Financial Stability Forum.

Fuller, S. L. (2008) "The Evolution of actively managed Exchange Traded Funds", *The Review of Securities and Commodities Regulation,* Vol. 41, No. 8, pp. 89-96.

Gabaix, X. and D. Laibson (2006) "Shrouded attributes, consumer myopia, and information suppression in competitive markets", *Quarterly Journal of Economics,* Vol. 121, No. 2, pp. 505-540.

Gai, P., S. Kapadia, S. Millard and A. Perez (2008) "Financial Innovation, Macroeconomic Stability and Systemic Crises", *The Economic Journal,* Vol. 118, No. 527, pp. 401-426.

Gastineau, G. L. (2002) "Equity index funds have lost their way", *Journal of Portfolio Management,* Vol. 28, No. 2, pp. 55-64.

Gastineau, G. L. (2004) "The Benchmark Index ETF Performance Problem", *Journal of Portfolio Management,* Vol. 30, No. 2, pp. 96-103.

Hansen, L. L. (2009) "Corporate financial crime: social diagnosis and treatment", *Journal of Financial Crime,* Vol. 16, No. 1, pp. 28-40.

Hendershott, T., C. M. Jones and A. J. Menkveld (2011) "Does Algorithmic Trading Improve Liquidity?", *The Journal of Finance,* Vol. 66, No. 1, pp. 1-33.

Hendershott, T. J. and R. Riordan (2011) "Algorithmic Trading and Information", *SSRN eLibrary Working Paper*.

Henderson, B. J. and N. D. Pearson (2011) "The dark side of financial innovation: A case study of the pricing of a retail financial product", *Journal of Financial Economics,* Vol. 100, No. 2, pp. 227-247.

Inderst, R. and M. Ottaviani (2009) "Misselling through Agents", *The American Economic Review,* Vol. 99, No. 3, pp. 883-908.

Kahn, C., G. Pennacchi and B. Sopranzetti (1999) "Bank Deposit Rate Clustering: Theory and Empirical Evidence", *The Journal of Finance,* Vol. 54, No. 6, pp. 2185-2214.

Kirilenko, A. A., A. S. Kyle, M. Samadi and T. Tuzun (2011) "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market", *SSRN eLibrary Working Paper*.

Mason, J. R. (2008) "The Summer of '07 and the Shortcomings of Financial Innovation", *Journal of Applied Finance,* Vol. 18, No. 1, pp. 8-15.

Menkveld, A. J. (2011) "High Frequency Trading and The New-Market Makers", *SSRN eLibrary Working Paper Working Paper*.

Miles, D. and V. Pillonca (2008) "Financial innovation and European housing and mortgage markets", *Oxford Review of Economic Policy,* Vol. 24, No. 1, pp. 145-175.

Miller, M. H. (1986) "Financial Innovation: The Last Twenty Years and the Next", *The Journal of Financial and Quantitative Analysis,* Vol. 21, No. 4, pp. 459-471.

Morrison, A. D. (2005) "Credit Derivatives, Disintermediation, and Investment Decisions", *The Journal of Business,* Vol. 78, No. 2, pp. 621-648.

Nie, Y. (2009), *Re-examining the Causes of Corporate Securities Fraud: A Criminological Approach.* The State University of New Jersey PhD thesis

Tibbs, S. L., D. L. Harrell and R. E. Shrieves (2011) "Do Shareholders Benefit from Corporate Misconduct? A Long-Run Analysis", *Journal of Empirical Legal Studies,* Vol. 8, No. 3, pp. 449-476.

Tufano, P. (2003) 'Financial innovation', in G. Constantinides, Harris, M., Stulz, R. (Ed.): *Handbook of the Economics of Finance*, pp. 307–336, Elsevier.

Van Horne, J. C. (1985) "Of Financial Innovations and Excesses", *The Journal of Finance,* Vol. 40, No. 3, pp. 620-631.

Zhang, F. (2010) "High-Frequency Trading, Stock Volatility, and Price Discovery", *SSRN eLibrary Working Paper*.